

EXHIBIT 3



BACHO V. ROUGH COUNTRY, LLC. ET AL

CASE NO: 13-564

Prepared for: Tom Willingham

Report date: August 27, 2014

A handwritten signature in black ink, appearing to read "Paul Lewis, Jr."

Paul Lewis, Jr.

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I. Introduction

I am a Biomedical Engineer who provides expertise in the areas of biomechanics, occupant kinematics, crash dynamics, and injury causation. Biomechanics is the study and effect of motion and forces on the human body. Kinematics is the study of motion- as applied to occupant kinematics it is the study of the body's motion. Dynamics is the study of forces on the human body that result in that motion and failure of the body due to the forces. These areas are related to medicine, but are separate disciplines. The role of a medical doctor is to diagnose an injury and treat it. The role of biomedical/biomechanical engineer is to identify the injury and measure the forces and motions necessary to cause the injury due to his/her specialized knowledge in injury mechanisms and tolerance values. My qualifications are set forth in detail in my Curriculum Vitae provided with this report.

This case involves an accident that occurred on December 22, 2012 on Lower Fayetteville Road at its intersection with Newnan Crossing Bypass in Newnan Georgia. Natalie Bacho was operating a 2012 Toyota Sienna minivan ("Toyota") east on Lower Fayetteville Road when a 1999 Chevrolet K-1500 pickup truck ("Chevrolet") driven by Taylor Long struck her vehicle on the driver's side. Per the accident report, Mr. Long told police that he was traveling south on Newnan Crossing Bypass when he saw the traffic light was red, he pressed his brake pedal and noticed his brakes were not working. He traveled through the intersection running the red light and struck the Toyota. This accident will be referred to as the "Incident".

The Chevrolet was equipped with an after-market lift kit manufactured by Rough Country, LLC and over-sized tires. These after-market structures will be referred to as "lift kit".

All of the occupants of the Toyota were utilizing their seatbelts. The following is general information regarding these occupants and the injuries they sustained:

- 1) Natalie Bacho, 41 year old female, driver - she sustained no injury of significance or that required treatment;
- 2) Charles Moore, 71 year old male, right front seat (#3) – he sustained no injury of significance or that required treatment;
- 3) Stephen Bacho, 44 year old male, left second row seat (#4) – he sustained multiple serious injuries including splenic injury, rib fractures, diaphragmatic rupture and sacral fractures;
- 4) Charlotte Bacho, 5 year old female, right second row seat (#6), restrained in a child seat - she sustained a small laceration under her left eye and a pulmonary contusion;
- 5) Hannah Bacho, 11 year old female, right third row seat (#9) - she sustained pulmonary contusion, fracture of the left side of the sacrum and left superior pubic ramus, and bruising from the seatbelt, and;
- 6) Abigail Bacho ("Abigail"), 9 year old female, third row left outboard seat (#7), she sustained fatal head injuries in the accident. Abigail is the subject of this suit.

II. Issues to be Addressed

I have reviewed this case in order to determine the following issues:

1. To determine and describe Abigail's occupant kinematics in relation to the crash forces, vehicle dynamics, vehicle structural intrusion, and the occurrence of her fatal head injuries;
2. To determine if Abigail's fatal head injuries are proximally related to the altered height of the lift kit on the Chevrolet;
3. To determine if the Chevrolet had been equipped with original equipment manufacturer ("OEM") height front structures if Abigail's fatal head injuries would have been prevented.

III. Database

I have reviewed the following case specific information:

1. ACCIDENT REPORT
2. INCIDENT REPORT FROM NEWNAN POLICE DEPT
3. DEATH CERTIFICATE FOR ABIGAIL BACHO
4. COLOR LASER COPIES OF BACHO VEHICLE BY GRAY
5. COLOR LASER COPIES OF ADVERSE VEHICLE BY GRAY
6. NEWNAN PD ANALYSIS COLLISION REPORT
7. AIR METHODS RECORDS FOR STEPHEN BACHO
8. MIDTOWN SPORTS MEDICINE RECORDS FOR STEPHEN BACHO
9. PIEDMONT NEWNAN HOSPITAL RECORDS FOR NATALIE BACHO
10. PIEDMONT NEWNAN HOSPITAL RECORDS FOR HANNAH BACHO
11. GEORGIA REHAB IMAGING OF WSMC RECORDS FOR HANNAH BACHO
12. VITAL CARE TRANSPORTS RECORDS FOR HANNAH BACHO
13. AMERICAN MEDICAL RESPONSE RECORDS FOR HANNAH BACHO
14. PIEDMONT NEWNAN HOSPITAL FOR CHARLOTTE BACHO
15. THE EMORY CLINIC RECORDS FOR CHARLOTTE BACHO
16. VITAL CARE TRANSPORTS RECORDS FOR CHARLOTTE BACHO
17. AMERICAN MEDICAL RESPONSE RECORDS FOR CHARLOTTE BACHO
18. AMERICAN MEDICAL RESPONSE RECORDS FOR ABIGAIL BACHO
19. MEDICAL IMAGES FROM CHILDREN'S HEALTHCARE OF ATLANTA FOR ABIGAIL BACHO
20. CHILDREN'S HEALTH CARE OF ATLANTA MEDICAL RECORDS FOR ABIGAIL BACHO
21. MEDICAL IMAGES FROM CHILDREN'S HEALTHCARE OF ATLANTA FOR CHARLOTTE BACHO
22. MEDICAL IMAGES FROM PIEDMONT NEWNAN HOSPITAL FOR CHARLOTTE BACHO
23. CHILDREN'S HEALTHCARE OF ATLANTA RECORDS FOR CHARLOTTE BACHO

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24. MEDICAL IMAGES FROM CHILDREN'S HEATHCARE OF ATLANTA FOR HANNAH BACHO
25. MEDICAL IMAGES FROM PIEDMONT NEWNAN HOSPITAL FOR HANNAH BACHO
26. CHILDREN'S HEALTHCARE OF ATLANTA RECORDS FOR HANNAH BACHO
27. MEDICAL IMAGES FROM PIEDMONT NEWNAN HOSPITAL FOR NATALIE BACHO
28. ATLANTA MEDICAL CENTER IMAGES FOR STEPHEN BACHO
29. ATLANTA MEDICAL CENTER RECORDS FOR STEPHEN BACHO
30. GA REHAB CENTER RECORDS FOR STEPHEN BACHO
31. HOME MEDICAL SYSTEMS RECORDS
32. OPERATING REPORTS FOR STEPHEN BACHO
33. COLOR LASER COPIES OF POLICE PHOTOS
34. NEWNAN FIRE DEPT REPORT
35. COMPLAINT
36. DEFENDANTS ANSWERS
37. POLICE SCALE TO DIAGRAM
38. SYSTEM VOLUME INFORMATION
39. VEHICLE BRAKE INSPECTION PHOTOS
40. GEICO EXPERT BRAKE INSPECTION VIDEO
41. COUNTY SOLICITOR'S FILE
42. DEPOSITION AND EXHIBITS OF KENNETH DUNN (TAKEN ON 4/27/11)
43. DEPOSITION OF KENNETH DUNN (TAKEN ON 8/4/14)
44. CRASH INVESTIGATION TEAM SPECIAL REPORT
45. REPORT OF DR. CHANDRA THORBOLE
46. PRELIMINARY INFORMATION FROM DR. DAVID RENFROE

The Toyota was not preserved after the Incident, therefore it was not available to inspect. However, I conducted a surrogate study on June 13, 2014 in Newnan, Georgia with an exemplar 2013 Toyota Sienna minivan.

V. Summary of Case Information

The following is simply a summary of what is stated in the case specific records. This summary does not contain any of my opinions.

1. Summary of information re: Abigail's injuries

A. Children's Healthcare of Atlanta Records:

Ambulance Record:

The call was received at 2023, at patient contact was at 2043, and arrived at the hospital at 2109.

Trauma, 10-year-old female involved in two-car MVC, unknown if patient was restrained, positive LOC. Intubated per EMS after extrication, vomit in the airway. No long bone fractures

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noted. Decortical posturing prior to flight. Onset of event occurred 20 minutes prior to calling EMS.

Under systemic information it includes that she had a small amount of edema noted to her forehead. No battle signs noted. Vomit noted in the airway.

Chest was symmetrical. She had no long bone fractures or deformities noted to her extremities and no abrasions or lacerations noted to her face.

The ambulance narrative includes again that she had no long bone fractures and had decorticate posturing prior to flight.

Anesthesia department assessment form states that her weight is 36 kg.

The pre-anesthesia assessment was a 10-year-old female status post MVC, respiratory failure intubated by EMS. CT showed diffuse cerebral edema, severe anoxic brain injury. Declared brain stem/cerebral hemisphere death on 12/24/12 at 11:16 a.m.

Anoxic brain injury, brain death, TBI, pelvic fracture, left femur fracture, acute respiratory failure, diabetes incipitus, mild coagulopathy, diffuse bilateral lower lobe mucopurulent secretions.

Discharge summary:

Admitting diagnosis was multiple sites of spinal cord injury without evidence of spinal bone injury, transtentorial herniation, traumatic brain injury, closed.

This is a 10-year-old female admitted to PICU after suffering a traumatic brain injury in a MVC. History obtained from AMP. Patient was backseat passenger (presumably restrained) and the car was involved in a T-bone accident on the driver's side. Patient was reportedly on the driver's side. EMS arrived and intubated patient on site. CPR performed and she reportedly went into V-TACH and even lost pulses briefly. Pupils dilated unreactive at site. Unclear how long she was in arrest and how long she received CPR. Patient transferred to EG-ER and found to have fixed dilated pupils. She was given one dose 3 percent HTS due to concern for TBI and increased ICP. CT concerning for anoxic brain injury.

Discharge diagnosis included:

- Anoxic brain injury
- Pelvis fracture
- Left femur fracture
- Acute respiratory failure
- Traumatic brain injury

Diffuse traumatic brain injury with a loss of consciousness of any duration with death due to brain injury prior to regaining consciousness.

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Physical Exam upon Admission:

Again the weight is listed as 36 kg.

She was unconscious.

HEENT:

No obvious bruise, fracture, laceration. Pupils fixed and dilated.

Her abdomen was slightly distended. The upper extremities were warm with good pulses and her lower extremities show externally rotated left leg.

Decorticate posturing with painful stimulus, no purposeful activity, pupils 6 millimeter fixed bilaterally, weak gag, rolls right shoulder to deep pain, flexes right arm.

Hospital course:

The minimal neurologic function that she had upon admission deteriorated and she had no discernable evidence of cortical or brain stem function by the next morning. Two brain-death exams were performed.

Awaiting final read of CT of her head, reportedly loss of grey-white differentiation, ventricles effaced.

Consult notes:

On 12/22/12 at 2227 hours shows that her pupils are 1 centimeter and non-reactive, no corneal reflexes bilaterally, weak gag reflex, decorticate posturing to pain and upper extremities.

CT of head without contrast showed diffuse cerebral edema and hypo density throughout the super tentorial compartment, small right frontal subdural hematoma, 5 millimeter right to left midline shift, effacement of basal cisterns and super cellular cistern.

Poor prognosis, likely non-survivable injury. No neurosurgical intervention is indicated.

Consult note dated 12/23/12 at 003 hours shows left iliac wing fracture, left subtrochanteric femur fracture.

Assessment was severe anoxic brain injury, left subtrochanteric femur fracture and left iliac wing fracture. Consultation dated December 22, 2012 shows that neurosurgery was consulted after CT of the head showed diffuse anoxic injury with right frontal acute SDH.

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Review of her system again shows no scalp lacerations, hematoma, rhinorrhea, sore throat or sinus congestion.

CT of the head shows diffuse hypo density in the supertentorial space consistent with diffuse hypoxic injury. Bilaterally effaced basilar cisterns with diffuse loss of gray-white junction. Acute right frontal SDH.

Emergency department notes dated December 22, 2012 at 9:09 p.m. showed traumatic brain injury, closed; multiple sites of spinal cord injury without evidence of spinal bone injury; transtentorial herniation.

Additional doctor notes state that head CT at 2207 showed bi-frontal extra axial blood, diffuse loss of gray-white matter and cerebral edema, 4 millimeters of right to left shift, downward transtentorial herniation. C-spine no acute fractures. Fracture of the left ilium, femur fracture.

Critical Care Medicine progress note on hospital Day 3 shows that initial neurologic function exam including apnea test was performed last night around 8:00 p.m. and was consistent with brain death. Expect to do final exam this morning.

Her diagnosis included anoxic brain injury, diffuse traumatic brain injury with loss of consciousness of any duration with death due to brain injury prior to regaining consciousness, brain death, traumatic brain injury, pelvic fracture, femur fracture, left and acute respiratory failure.

Neurological exam done on December 23, 2012 at 2043 hours showed irreversible cessation of all activity in the cerebral hemispheres and brain. A confirmatory exam will be performed in approximately 12 hours by a second physician.

Progress note dated December 23, 2012 at 0934 hours shows that there is no expectation for neurologic recovery. Life Link was made aware of patient.

X-ray of the chest taken 12/22/12 at 2138 showed minimal left lower and right upper lobe atelectasis.

CT of the chest, abdomen and pelvis with contrast taken 12/22/12 at 2202:

Abdomen:

Apart from mild peri-portal edema the liver appears normal without subcapsillary hematoma or laceration. No obvious splenic injury. Linear hypo density near the upper pole does not appear to represent a laceration. Right adrenal hemorrhage is present.

The pelvis showed no regional right pelvic or sacral fracture evident. A symmetric region of soft tissue density abutting the right posterior lateral wall of the rectum within enhancing vascular structures traverse.

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There is a fracture of the inferior left ilium which extends inferiorly to the cartilage in the left acetabular roof. Alignment appears near anatomic. There is a comminuted avulsion fracture near the left inferior pubic ramus junction at the pubic symphysis. This fracture is seen best on coronal reconstructions with overall elevation of the left pubis when compared to the right. There is also an oblique right fracture of the proximal left femoral diaphysis.

Impression:

1. Right adrenal hemorrhage.
2. Fractures of the proximal left femoral diaphysis, inferior left ilium and left pubic rami as detailed above.
3. Asymmetric soft tissue in the right lower pelvis abutting the posterior lateral wall of the rectum with which are arterial and venous structures leading to the internal iliac system. Unclear if this is posterior traumatic in nature (given the absence of regional fractures) or pre-existing underlying vascular abnormalities such as a vascular malformation.
4. Tiny regions of ground glass attenuation bilaterally and keeping with the small regions of contusions.

Pelvis x-ray taken 12/22/12 at 2124 hours showed a fracture involving the proximal left femur, it appears to traverse the intertrochanteric region. There is additional linear lucency through the inferior iliac wing extending to the acetabulum. The pubic symphysis is splayed with the left pubic symphysis while above the right pubic symphysis. Soft tissue swelling of the left hip is noted. Sacroiliac joints appear symmetric.

Proximal femoral fracture through the right intertrochanteric region is re-demonstrated without significant displacement or angulation. Pelvic fracture through iliac wing with asymmetry of the pubic symphysis is also partially included. The distal femur appears intact however the inferior most aspect of the femoral condyles is excluded from the image.

Single portable frontal view of the pelvis and frontal view of the left femur taken 12/22/12 at 2320: Impression:

1. Complex left pelvic fracture with iliac wing fracture extending to the acetabular roof, pubic symphysis asymmetry with frank diastasis and proximal left femoral intertrochanteric fracture.
2. The distal femur appears intact, however the distal most aspect of the articular surface of the femoral condyles is partially excluded.

CT of the head without contrast taken December 22, 2012 at 2120 hours: Findings:

Hyper dense extra axial collections overlying the bi-frontal convexities, right greater than left, measuring up to 4 millimeters and maximal thickness along the right frontal convexity. There is diffuse obscuration of the gray right differentiation as well as diffuse sulcal effacement consistent with diffuse cerebral edema. There is effacement of the basilar cisterns consistent

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with downward transtentorial herniation. Three millimeters right to left midline shift of the foramen of Monro is present.

No skull fractures demonstrated. A 6-millimeter hyper density consistent with a foreign body is seen in the inferiomedial to the left globe in association with a skin laceration.

Impression:

1. Bi-frontal extra axial hemorrhage measuring up to 4 millimeters maximal thickness.
2. Poor gray-white differentiation consistent with hypoxic brain injury.
3. Diffuse cerebral edema with downward central transtentorial herniation and obliteration of the basilar cisterns.
4. Three millimeter right to left midline shift.
5. Left infraorbital soft tissue laceration containing 6-millimeter superficial foreign body.

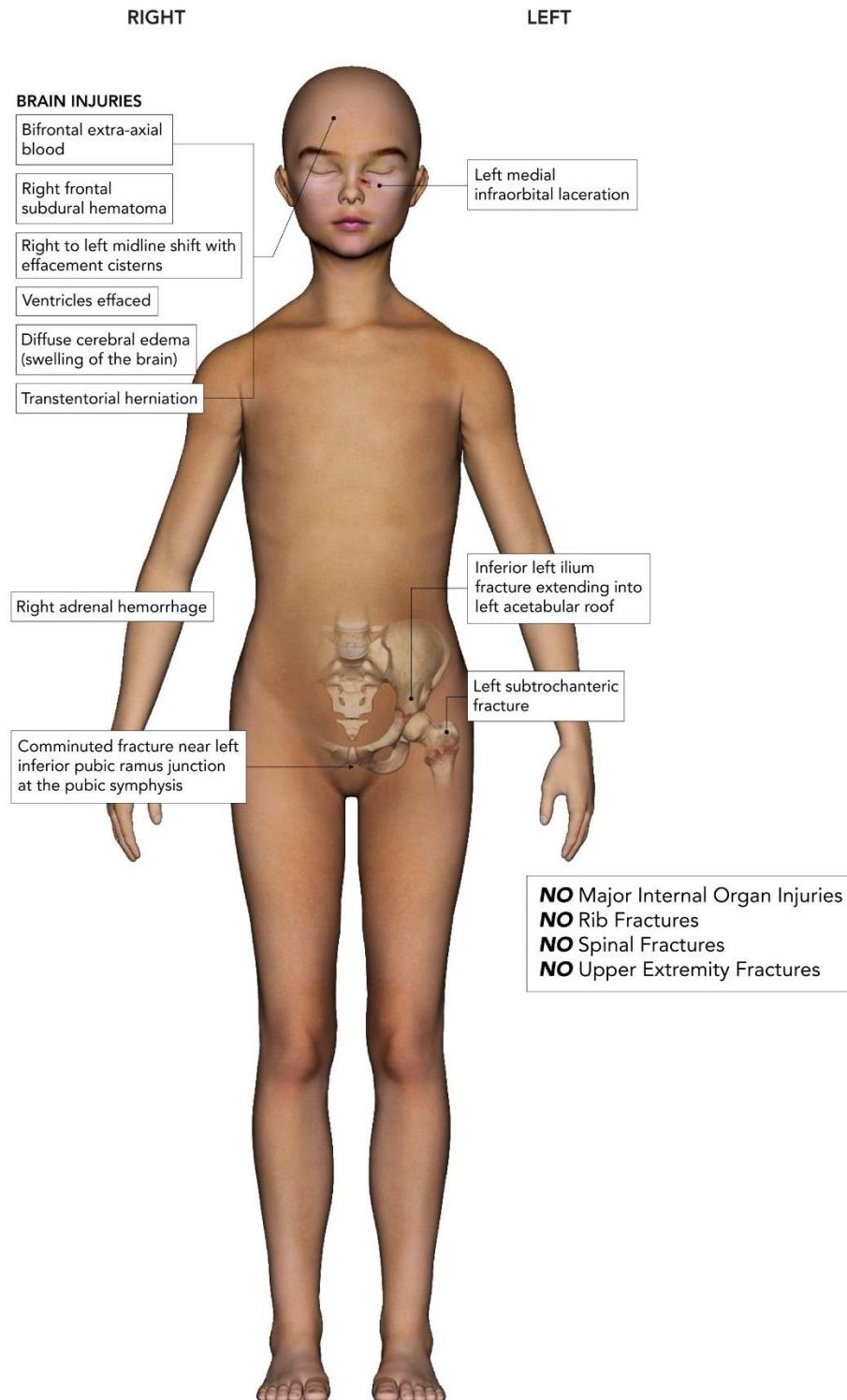
CT of the cervical spine without contrast taken December 22, 2012 at 2124: Impression was no evidence of acute fracture or dislocation of the cervical spine and right apical pulmonary contusion.

B. Injury Diagrams

The following diagrams were created at my direction to illustrate generally the nature and location of Abigail's injuries. These diagrams are in no way intended to be exact, just a general representation.

(Blank spaces are left intentionally to allow for larger diagrams.)

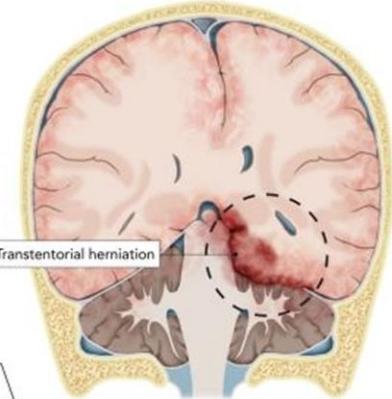
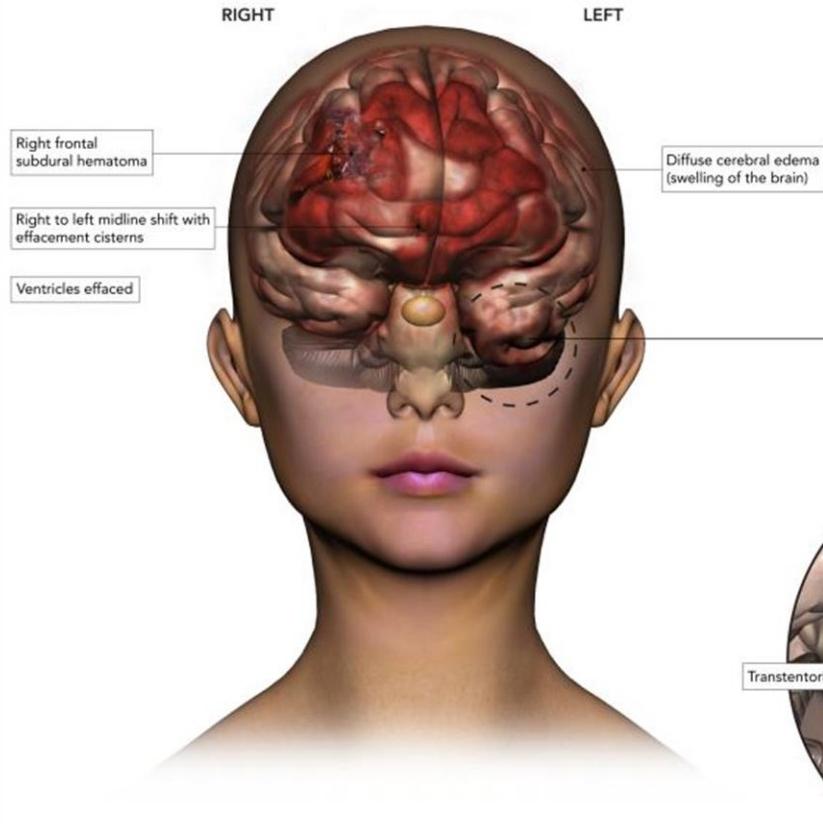
Abigail Bacho: Injury Summation



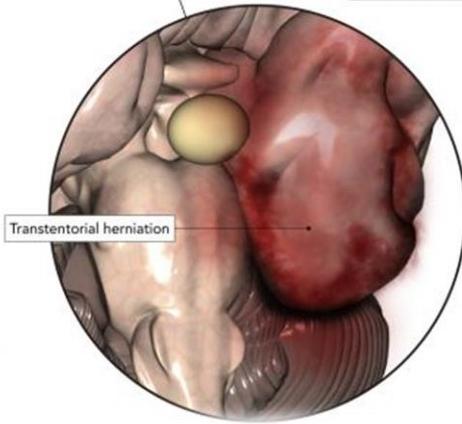
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Abigail Bacho: Head Injuries

CORONAL VIEW OF THE BRAIN



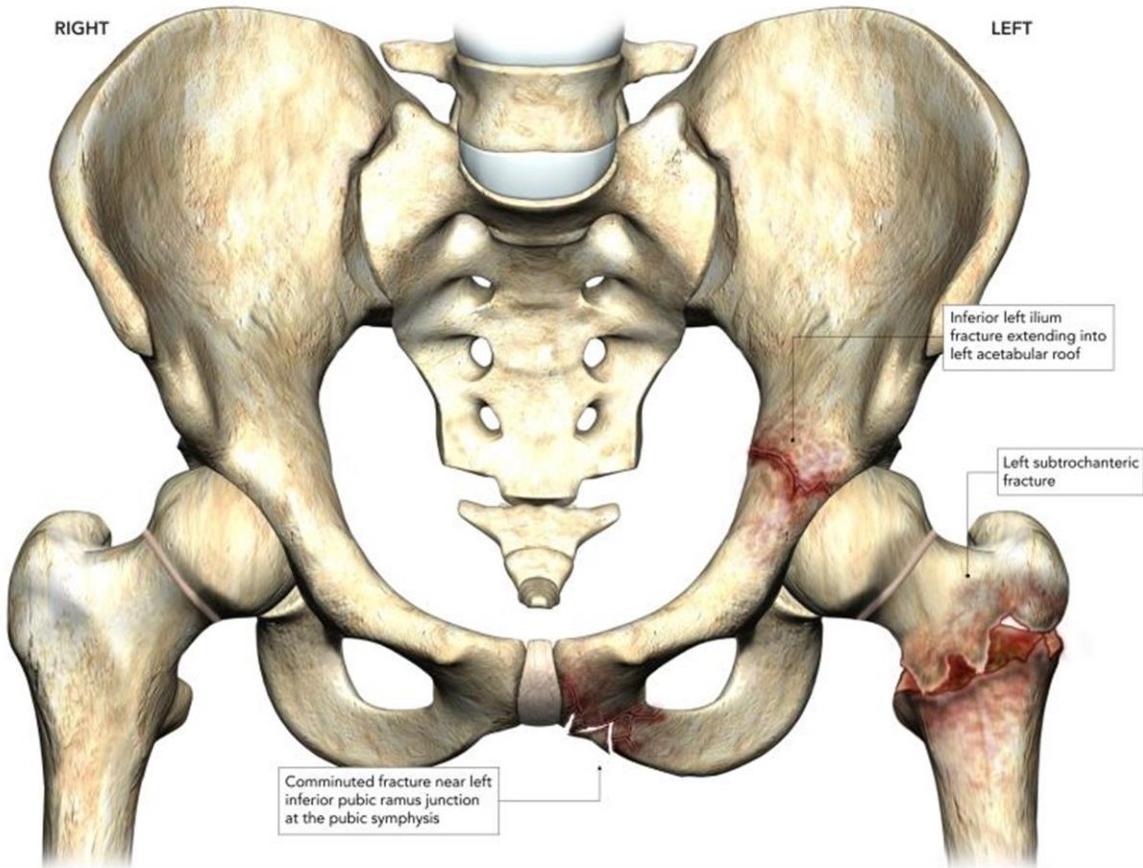
INFERIOR PERSPECTIVE



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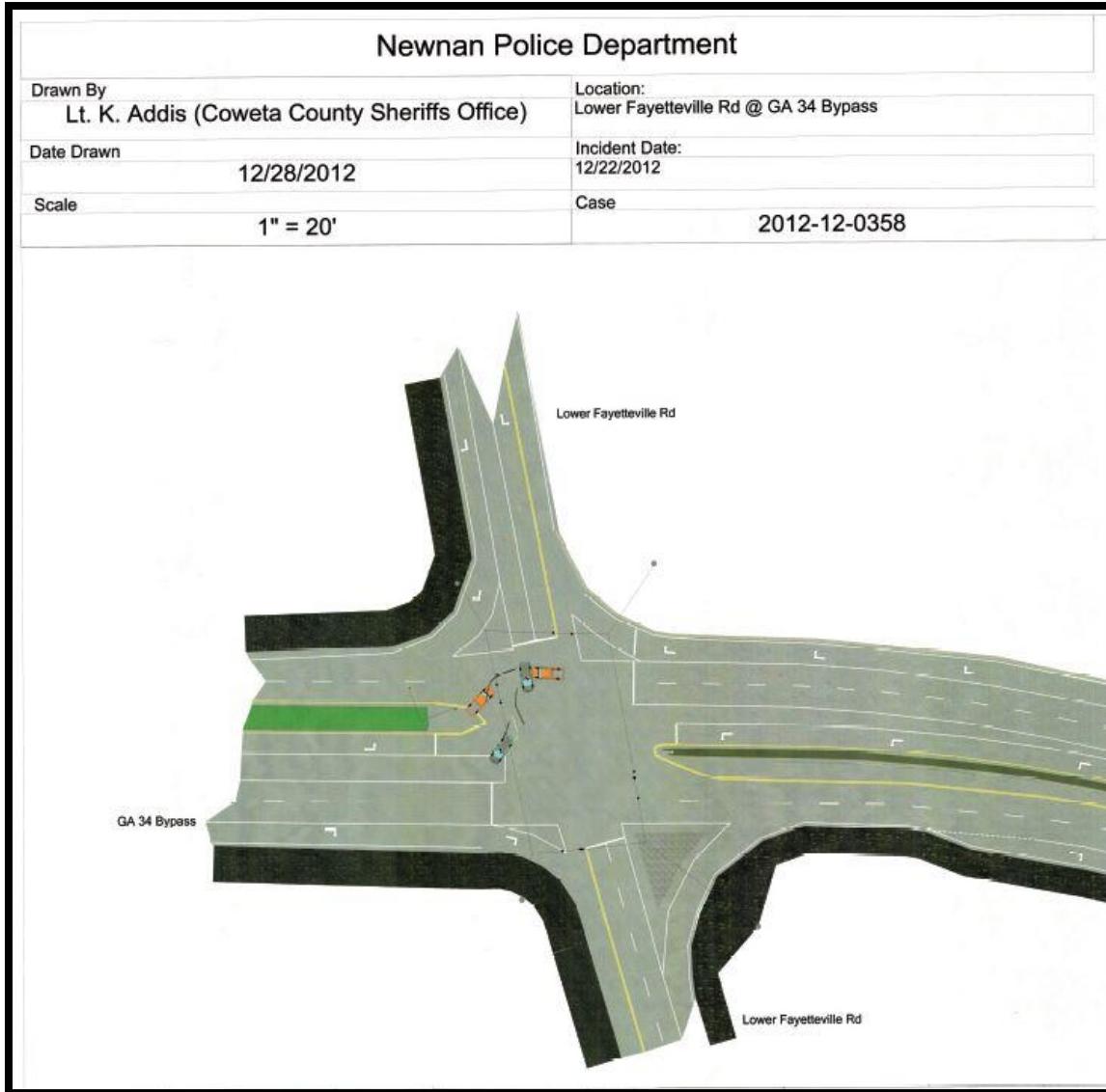
Abigail Bacho: Pelvic and Leg Injuries

ANTERIOR VIEW OF THE PELVIS



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2. Scaled Police diagram



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3. Photographs of the Toyota and Chevrolet taken by Steve Gray show deformation profile to both vehicles:

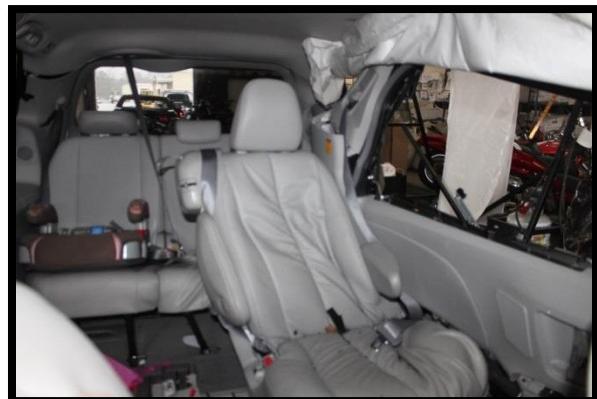
Toyota



Images 4 and 6



Images 36 and 41



Images 43 and 48

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Images 46 and 65

Chevrolet



Images 8 and 10



Images 11 and 14

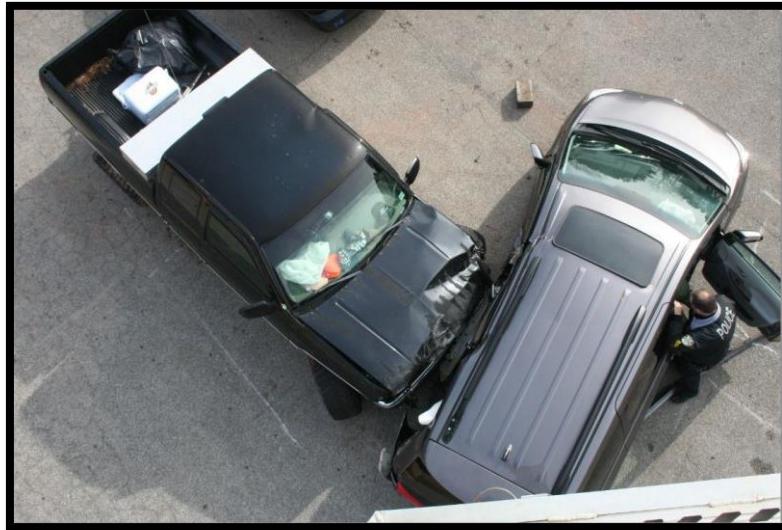
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4. **Police photographs of the Toyota and Chevrolet**

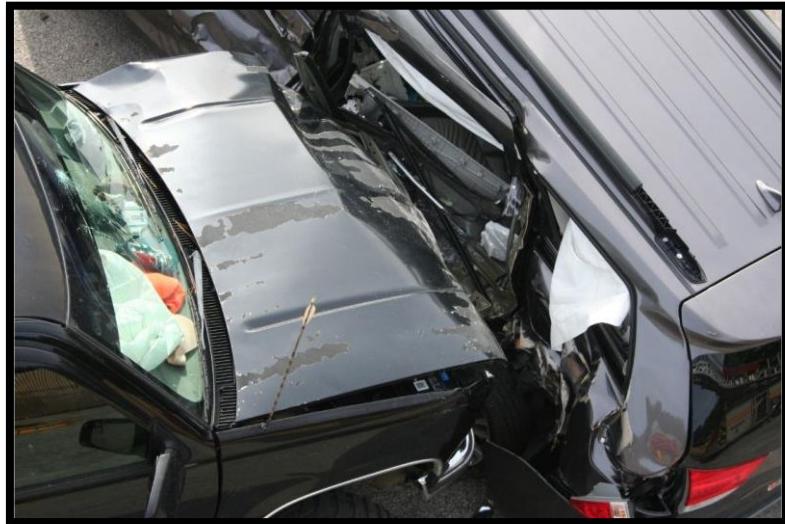
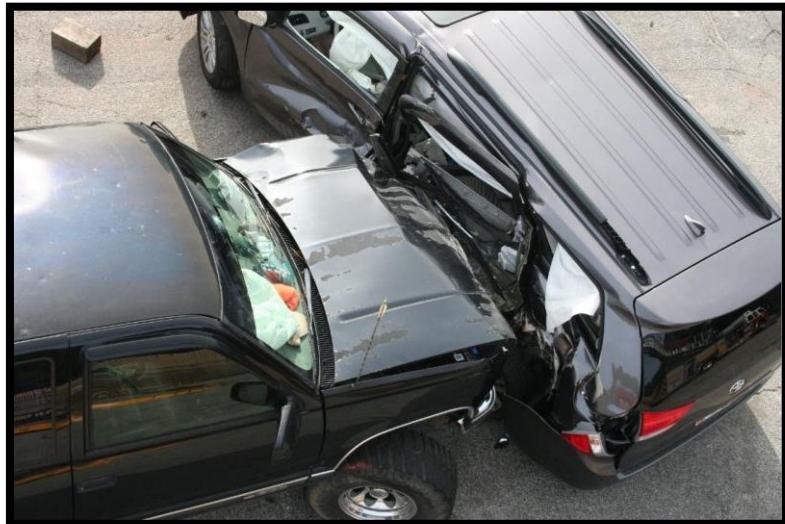
The following two police photographs are included to show that there is no obvious blood in and around Abigail's seated position or on the side airbag.



The following photographs were taken by the police when they lined up the Chevrolet and the Toyota. It is noted that this is a static recreation and the dynamic crush would have been greater.



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5. Photographs from Renfroe Engineering:

Renfroe Engineering aligned exemplar vehicles to show the height differential between an OEM Chevrolet and a Chevrolet with a lift kit.



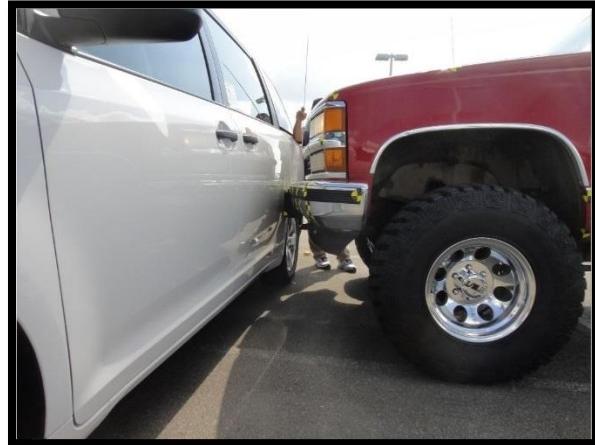
OEM



Lift kit



OEM



Lift kit

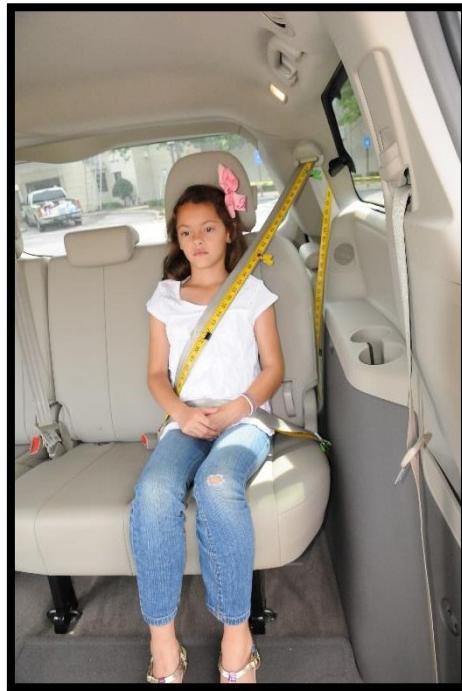
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Lift kit

6. Bioforensic surrogate study

Information received regarding Abigail's height and weight is that she was 53" tall and weighed 72 pounds at the time of the Incident. The surrogate utilized was 52" tall and weighed 53.8 pounds.



7078 – The surrogate was asked to seat in a normal seated position and put on the three point restraint.

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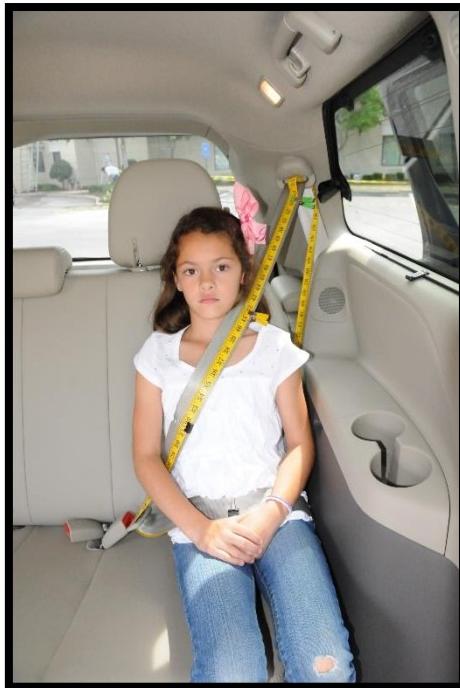


7078- In this position the center of her forehead was approximately 18 inches from the plane of her nearside window.



7089- In this same position the center of her torso/abdomen was approximately 11 inches away and her left hip approximately 6 inches away from her near side vehicle structures.

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7091- The surrogate was then asked to move her body to the left in close contact with the side structures of the exemplar.



7093- In this position the center of her forehead was approximately 14 inches away from the plane of her nearside window and the left side of her head approximately 10 inches away from the interior panel.

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7095- In this same position the center of her torso/abdomen was approximately 12 inches away from her near side vehicle structures.

7. Side curtain airbag coverage in the Sienna

The following image is taken from Toyota's brochure for the Sienna and shows the area of side curtain airbag coverage. The yellow line has been drawn in the rear window to indicate the area of airbag coverage for Abigail's position.



8. Reconstruction and other information from Engineer Dr. David Renfroe

Reconstruction:

The speed of the Chevrolet at impact was approximately 34.5 mph. The speed of the Toyota was approximately 35 mph. Both vehicles rotate counterclockwise as a result of the collision. The

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post impact speed of the Chevrolet truck was approximately 22 mph. The post impact speed of the Toyota was approximately 27 mph.

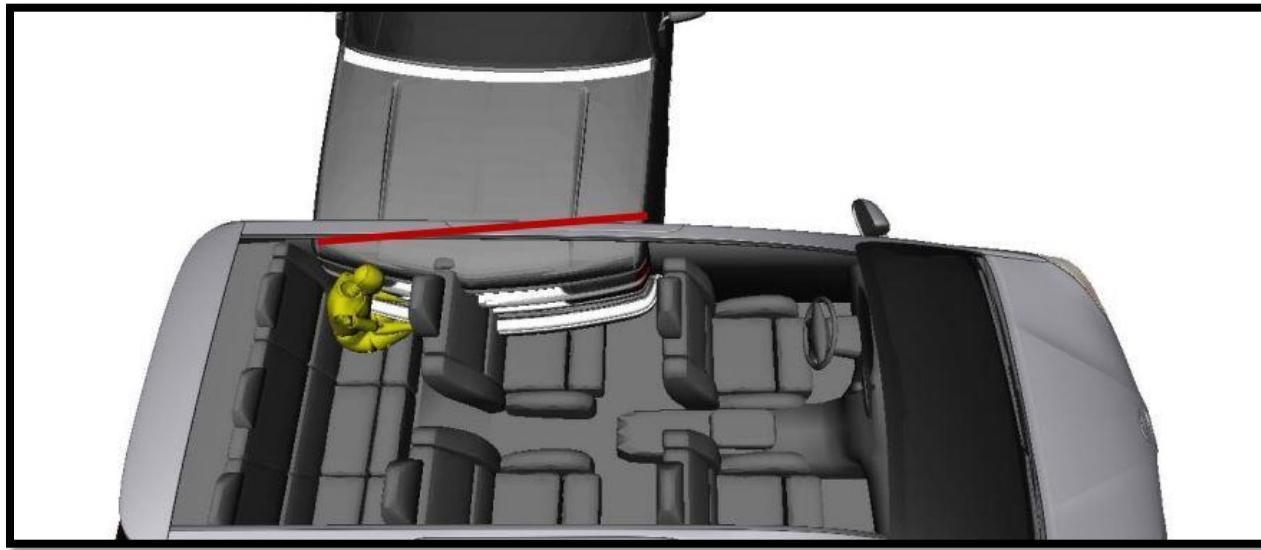
The Chevrolet truck experienced a Delta V of approximately 17 mph and the Toyota experienced a Delta V of approximately 16 mph. The Principle Direction of Force of the crash pulse on the Toyota was approximately 46 degrees clockwise. Zero degrees is straight forward with respect to the Toyota.

Collision Analysis includes:

Evidence on the subject pickup indicates the front bumper overrode the left rear tire of the Toyota Sienna during the collision.

The approximate locations of the Toyota's Sienna's B and C pillars are seen "imprinted" on the hood of the Chevrolet pickup truck. This is evidenced by a lack of abrasions in these two positions. The surrounding areas have sweeping abrasions from the Toyota Sienna's side glass scratching the paint on the hood. During the collision the Toyota Sienna's airbags deployed against the side glass holding it in place as the encroaching pickup hood abraded against the "crumbling" glass. The distance between the Toyota B and C pillars is approximately 47 inches which is consistent with the hood of the pickup.

Dr. Renfroe's report includes the following demonstration of a scaled dummy in the 3rd row seating position and the intruding pickup truck. The red line indicates the approximate extent of the crush on the pickup.



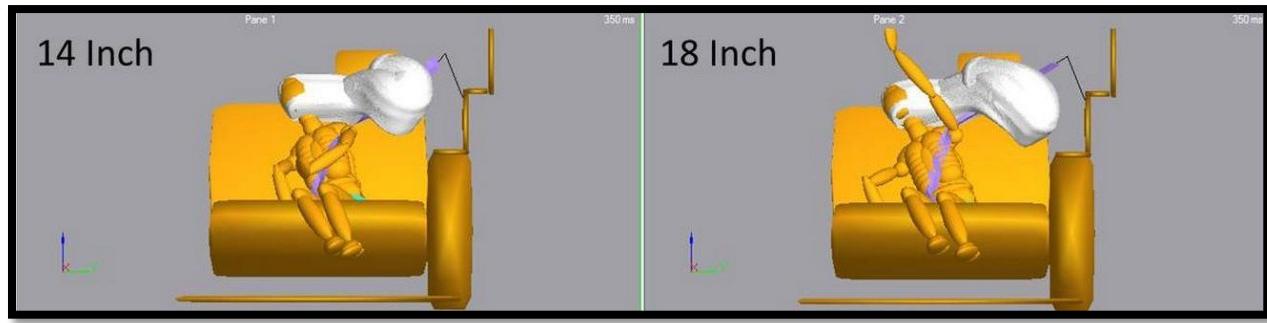
9. MADYMO analysis by Dr. Chandra Thorbole

A case specific MADYMO analysis was done by Dr. Chandra Thorbole to determine what the head and body motion of Abigail would have been without any vehicle intrusion. He performed

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two simulations both utilizing Dr. Renfroe's reconstruction information and a scaled Hybrid III 6 year old ATD: one with the head 14 inches away from the window and one with the head 18 inches away from the window.

The following diagram is the head motion trace to examine the head trajectory and potential location of head contact if no vehicle intrusion. The head does not make contact in either scenario with any portion of the interior side structures.



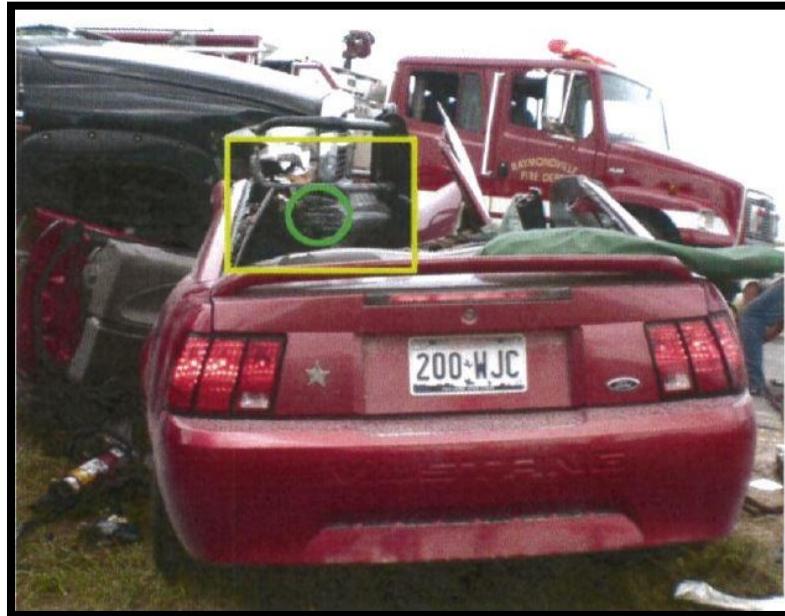
Dr. Thorbole also calculated the HIC for these two scenarios: 1) 14 inch head distance HIC(15) 21.8 and HIC(36) 27.225, and 2) 18 inch distance HIC(15) 74.16 and HIC(36) 97.3. He also found that the NIJ values for tension-extension and tension-flexion were well below the IARV.

10. OSI

I was involved as a biomedical expert in a case involving a Rough Country lift kit. A 2006 Dodge Ram truck equipped with the lift kit impacted a 1999 Ford Mustang in the left front. The driver's head was impacted by the truck's bumper causing her skull fractures, traumatic brain injury, and permanent impairment.



Accident scene photograph



Accident scene photograph with the yellow box indicating the area of the Dodge's bumper that has intruded into the Mustang's occupant space and the green circle indicates the area where the driver's head was approximately located.

V. Opinions and Support

1. My opinions regarding Abigail's occupant kinematics in relation to the crash forces, vehicle dynamics, vehicle structural intrusion, and the occurrence of her fatal head injuries are as follows:

- 1.1 The impact of the front of the Chevrolet into the driver's side of the Toyota will cause Abigail's body to move leftward and forward and at the same time she will begin to engage her lap and shoulder restraint coupling her to the vehicle. As a result of the shoulder belt engagement to her body, this would create a forward, leftward, and downward arc of her head in relation to her thorax. Her head will continue to move rapidly downward over the seatbelt meeting the rapidly intruding interior panel which is bolstered by the mismatched and elevated aggressive front structures of the Chevrolet pickup truck into the upper side of the Toyota.
- 1.2 This impact by the intruding side panel to her head results in the massive internal head and brainstem/cord injuries that resulted in her death. Her injury pattern is consistent with interaction with the broad based smooth interior panels she does not have any open lacerations (other than an extremely small left medial infraorbital laceration), obvious abrasions, dicing injuries, or skull fractures as a result of the contact. Additionally her brain injuries are more diffuse than focal in nature.
- 1.3 My surrogate study showed the relationship of Abigail's head to her side panel, which showed the spatial relationship is consistent with the side panel being available for her

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head to interact with. Abigail's head injury pattern is inconsistent with a direct impact through the window opening to the front of the striking vehicle. However, the increased force, weight, and intrusion associated with the side panel and its bolstered interaction by the lifted front of the vehicle do result in the impact to her head that causes her fatal injuries.

- 1.4 The deformation due to the altered elevation of the striking vehicle causes excessive crush into her occupant survival area causing rightward movement of the interior trim panel and the underlying exterior sheet metal. During this deformation the left side of her pelvis will be engaged by the left side of the vehicle effectively fixing her pelvis thus causing rotation of the head and upper torso in relation to her pelvis. This interaction of her pelvis and lower extremities with the left side of the vehicle creates her left iliac wing fracture and left subtrochanteric femur fracture.
- 1.5 As per Dr. Renfroe's measurements, the front bumper of the Chevrolet struck between the B and C pillar of the Toyota. Abigail's father, Stephen Bacho was in the second row left seat in front of Abigail. Mr. Bacho sustained multiple severe injuries including splenic injury, rib fractures, diaphragmatic rupture and sacral fractures.
- 1.6 I had the opportunity during my surrogate study to place Mr. Bacho in the exemplar Sienna. Mr. Bacho is 6' tall and 190 pounds. The two photographs of him below illustrate the location of his head in reference to the roof and pillar structures and door verses the third picture of the surrogate which illustrates the difference in how much significantly lower Abigail's head would have been. His head is located in the protective confines of the side curtain airbag as evidenced by his injury profile of chest, abdominal, and lower extremity injuries due to his stature. His lower body is located in the area of the intruding Chevrolet that would have had greater intrusion but for the interaction with the C pillar and side door beams that were not present at Abigail's position.



7147 and 7149



7099

2. **Abigail's fatal head injuries are proximally related to the altered front height due to the lift kit on the Chevrolet and its aggressive interaction with the upper panel of the Toyota. Support for this opinion will be provided in Opinion 3.**
3. **Had the Chevrolet been equipped with OEM height front structures Abigail's fatal head injuries would have been prevented and she would have been expected to receive non-life threatening injuries with no permanent sequelae.**
 - 3.1 The IIHS has released numerous research regarding vehicle compatibility. The lightest passenger cars, pickups, and utility vehicles, which are also the smallest typically have the highest death rates and the heaviest and largest have the lowest. Weight is a factor but so is vehicle stiffness and geometric design. The more these differ between vehicles, the more incompatible they are in terms of crashworthiness. ("Crash Compatibility, how vehicle type, weight, affect outcomes", Status Report, Volume 33, No 1, February 1998).
 - 3.2 To explore the issue of how compatibility characteristics affect vehicles in side impacts the IIHS conducted 6 vehicle to vehicle crash tests with the striking vehicle going 30 mph and the truck vehicles going 15 mph. In each case the struck car was the Mercury Grand Marquis, but the weight, stiffness, and ride height of the striking vehicle varied from test to test. Striking the Grand Marquis was one Lincoln Towncar and 5 Ford F-150 pickup trucks, four 4 x 2, and one 4 x 4. The basic Ford 150 4 x 2 weighs about the same as the Towncar and has about the same ride height, but it is stiffer. The 4 x 4 pickup is heavier, rides higher, and is stiffer than the 4 x 2. ("Special Issue: Vehicle compatibility in crashes", Status Report, Volume 34, No. 9, October 30, 1999).
 - 3.3 These tests illustrate the effects of a higher, heavier, and stiffer vehicle impacting one that is lighter, less heavy and stiff in a side impact.

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- In the first test involving the Lincoln Town Car the dummy measures in the struck car were below the thresholds indicating significant injury likelihood. In the second test where a basic Ford F-150 4 x 2 pickup hit the side of the Grand Marquis, none of the head, chest or pelvis measures exceeded thresholds indicating serious injury likelihood.
- In the third test, the F-150 4 x 2 with a raised ride height struck the Grand Marquis and there were big increases in all three chest injury measures and the dummy's head was struck by the intruding F-150's hood.
- In the fourth test the F-150 4 x 2 was given increased weight and the crash test produced one higher chest injury measure and the dummy's head was again struck by the pickup's hood.
- In the fifth test the F-150 4 x 2 was given increased height and weight and produced the most extensive deformation yet to the Marquis, the worst chest injury measures, and again the dummy's head was struck by the pickup's hood.
- In the last test the 4 x 4 version of the F-150 was used and has a high ride height and is the stiffest of all the striking vehicles. It inflicted the most structural damage and the dummy's head strike was severe. In the first test with the Lincoln Town Car, the dummy's HIC was 75 in comparison to the HIC of 717 produced in this test.

- 3.4 The conclusion of the test results was that heavier, stiffer, and higher striking vehicles inflict more damage to struck vehicles and increase the likelihood of serious occupant injury. Increased vehicle height clearly affected injury risk in terms of likelihood of head contacting the striking vehicle and thoracic injury. Increased mass further increased the risk of a head strike. ("Crash compatibility issue in Perspective", Lund, O'Neill, Nolan, Chapline, SAE 2000-01-1378).
- 3.5 The Toyota and the Chevrolet without a lift kit would not be "incompatible vehicles" in that they are both large, heavy vehicles. The gross vehicle weight of a 2012 Toyota Sienna is 5,995 pounds and the 1999 Chevrolet K-1500 had a gross vehicle weight 6,200 pounds without a lift kit. The weight difference is minimal.
- 3.6 This compatibility is demonstrated in Dr. Renfroe's exemplar photographs. The below picture on the left shows that without the lift kit, the Chevrolet's bumper would engage the wheel and tire and wheel well area well below the top of the wheel well and the other frontal structures such as the hood engage with the Toyota well below the rear window area where Abigail was seated. The picture on the right shows that when the Chevrolet has a lift kit it's bumper engages the Toyota at the top of the wheel well, missing any resistance from the wheel and tire and the other stiffer frontal structures of the truck engage the vehicle in an area that is effectively just sheet metal that is less significantly stiff.



OEM



Lift kit

- 3.7 But for the Chevrolet being at an elevated height causing excessive crush into her occupant space, there is nothing about this crash that was life threatening or seriously injurious to Abigail. A Delta V of 16 mph has an essentially 0% risk of producing fatality to an occupant and less than 20% chance of producing AIS 3+ injuries. ("Relationships Between Crash Casualties and Crash Attributes", Malliaris, Digges, and DeBlois, SAE 970393).
- 3.8 The importance of the concept of occupant containment and protection has been known for decades. In 1952 Hugh Dehaven stated that early in World War II the study of human survival in falls from heights of 100 or more feet and research on the nature and cause of injuries in aircraft accidents, showed that the human structure, if properly packaged could tolerate extremely severe conditions of crash force. As applied to motor vehicle crashes, he looked at fatal car crashes studied by the Crash Injury Research Division of the Indiana State Police and found that in many of the fatal cases, other people were in the same car and escaped uninjured or sustained injuries which normally would not endanger lives. Obviously crash force alone was not the killer. ("Accident Survival- Airplane and Passenger Car", Hugh Dehaven, SAE No. 003743, 1952).
- 3.9 Testing reports from the IIHS and NHTSA regarding the performance of the 2012 Toyota Sienna in side impact testing shows that it was a safe "package" for Abigail to be contained in. This is especially true in consideration of the fact that all of the testing performed is run at a higher collision severity in terms of miles per hour than the subject collision and the Sienna still performed extremely well.
- 3.10 The IIHS side impact testing is intended to address a key aspect of vehicle crash compatibility- the increased risk of fatality for side struck occupants when the striking vehicle has a higher front profile. The Institute's website states that this side test "...is severe. It's unlikely that people in comparable real-world crashes would emerge uninjured. With good side protection, however, people should be able to survive a crash of this severity without serious injuries." ("Changes in Vehicle Designs from Frontal Offset and Side Impact Crash Testing", Lund and Nolan, SAE 2003-01-0902).

- 3.11 The IIHS side impact test report for the 2012 Toyota shows that measures from the driver and passenger dummy in the testing indicate a low risk of any significant injuries in a crash of this severity which is almost double that of the subject Incident. The driver dummy only had a HIC of 172 and the rear passenger had a HIC of 202, both of which are extremely below the injury threshold. This testing showed that the Sienna provides good side protection in a severe crash and the resultant injury values are injuries that are non-life threatening or permanently debilitating. (IIHS test report for 2012 Toyota Sienna).
- 3.12 The NCAP Moving Deformable Barrier Side Impact Test for the 2011 Toyota Sienna, with the impact velocity of the moving deformable barrier being approximately 38 mph, showed the driver had a HIC of only 54. The passenger ATD seated in the second row behind the driver only sustained a HIC of 107. (NTHSA Number MB5104).
- 3.13 The NCAP Side Impact Pole Test, a 20 mph 75 degree oblique impact with an approximately 19 ½ mph impact velocity, showed that the driver HIC was 413, that while higher than the two previously referenced report, is still less than half of the injury threshold of 1,000.
- 3.14 Referencing back to the principles of crash survival established by Dehaven, again, this side impact testing shows that the Sienna was a safe package for Abigail. Crash force alone was not the cause of her fatal injuries. There were people in the same car that escaped injuries which would not normally endanger lives. She should have had the same injury profile as the essentially uninjured occupants but for the intervening factor that the lift kit on the Chevrolet caused excessive crush of her protective package that the essentially uninjured occupants did not experience.
- 3.15 The human model simulations and reconstruction performed for this case regarding a different impact configuration with a lowered vehicle thus resulting in effectively no intrusion of the left side panel of the Toyota reveal there would be no subsequent occupant head contact and thusly no life threatening or fatal head injury to result. Furthermore these results show that any of the measured IARVs for head and neck are well below any of the thresholds for catastrophic, severe injuries to the head/brain/neck.
- 3.16 Had the Chevrolet not been equipped with the lift kit, there would not have been excessive intrusion into Abigail's occupant space. Especially in consideration of the relatively low crash severity, Abigail's fatal head trauma would have been prevented.

VI. Qualifications and Methodology

I am a Biomedical Engineer who provides expertise in biomedical/biomechanical engineering related to injury causation and prevention and occupant kinematics.

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My educational background consists of a Master of Science in Biomedical Engineering from the University of Alabama Birmingham received in 1995 and a Bachelor of Science Industrial Engineering from the University of Alabama received in 1991.

From September 1996 through September 1998 I was an intern at the Office of the Medical Examiner in Metropolitan, Atlanta, Georgia. In September 1998 I began working for Burton & Associates, a consulting firm, which is now located in Alpharetta, Georgia. In 2011 I formed my own company, Bioforensic Consulting, Inc. providing consulting in the areas of biomedical and biomechanical engineering, occupant kinematics, and injury causation in a wide range of accident scenarios including transportation crashes.

As a Forensic Investigator and Primary Biomechanical Engineering Consultant I have assisted with on scene and follow up investigation of traffic fatalities, homicides, suicides and natural deaths. I have also assisted in postmortem examinations, autopsies and exhumations of victims to determine cause and manner of injuries and death.

As of 2013 I have been involved in the investigation of approximately 3,500 plus vehicle accidents with fatality or significant injury. Further, I have been involved in numerous forms of testing simulating automobile accidents with and without dummies, and I have co-authored several papers pertaining to such. A list of these, as well as further details of my background and training, is contained in my attached Curriculum Vitae.

In my evaluation of the cases I review and of this specific case, I utilized the Scientific Method of Analysis in order to answer the questions that you have posed.

The Scientific Method requires the following: 1) A statement of the problem, 2) An orderly review and course of study involving the collection of facts, data and information concerning the problem to be addressed, 3) The formation of an opinion or hypothesis based on the evaluation of the above, 4) Testing the validity of the hypothesis. Such testing may take numerous and varied approaches and does not necessarily require some physical or mechanical test procedure, and 5) Consideration for the potential for error in the conclusions and opinions stated.

These principles are applied to my case investigation leading to the arrival of my conclusions in the following report specific to this case.

My deposition and trial fees are \$400/hour.